

Appl. No. 10/719,897
Amdt. Dated November 21, 2007
Reply to Office Action of August 22, 2007

Attorney Docket No. 81707.0190
Customer No. 26021

REMARKS/ARGUMENTS:

Claims 19-21 are canceled without prejudice. Claims 9, 10, 15, and 18 are amended. Claims 9-18 are pending in the application. Reexamination and reconsideration of the application, as amended, are respectfully requested.

CLAIM REJECTIONS UNDER 35 U.S.C. § 103:

Claims 9-21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Hayashi et al. (U.S. Patent No. 6,143,116) in view of Ogata et al. (U.S. Patent No. 6,159,322). This rejection is moot with respect to claims 19-21 due to the cancellation of these claims. The Applicant respectfully traverses this rejection as to claims 9-18. Claim 9, as amended, is as follows:

A method of producing a multi-layer circuit board by preparing a circuit-parts sheet which comprises a photo-cured ceramic sheet and a circuit-forming pattern through the steps (a) to (e) described below and, then, conducting the steps (f) to (h) described below:

(a) forming the circuit-forming pattern having light-nontransmitting property on a surface of a carrier film having light-transmitting property;

(b) forming a photo-curable ceramic coating layer having a thickness not smaller than the thickness of said circuit-forming pattern and in which said circuit-forming pattern is buried, by applying a photo-curable slurry containing an electrically insulating ceramic material on the surface of the carrier film on which said circuit-forming pattern is formed;

(c) forming a photo-cured ceramic sheet by photo-curing said photo-curable ceramic coating layer which is not present on the circuit-forming pattern by the irradiation with light from the back surface of

said carrier film, wherein the photo-curable ceramic coating layer which is present on the circuit-forming pattern is not photo-cured;

(d) removing uncured portions of said photo-curable ceramic coating layer by using a developing solution;

(e) peeling off said carrier film;

(f) preparing a plurality of pieces of the circuit-parts sheets obtained through the steps (a) to (e);

(g) laminating a plurality of pieces of the circuit-parts sheets; and

(h) firing the laminate thereof.

Applicant respectfully submits that the cited references cannot render claim 9 obvious, because the cited references fail to teach or suggest "forming a photo-cured ceramic sheet by photo-curing said photo-curable ceramic coating layer which is not present on the circuit-forming pattern by the irradiation with light from the back surface of said carrier film, wherein the photo-curable ceramic coating layer which is present on the circuit-forming pattern is not photo-cured."

An important aspect of the present invention is that a circuit-forming pattern (comprising, for example, an electrically conducting paste) that does not permit light to pass through, is formed on a light transmitting carrier film, a photo-curable ceramic coating layer is formed so as to completely cover the pattern, and the back side of the carrier film is irradiated with light (exposed to light) followed by developing to form a circuit-parts sheet on the carrier film.

When the back side of the carrier film is irradiated with light, as discussed above, only those portions present on the circuit-forming pattern remain not cured in the photo-curable ceramic coating layer while other portions are cured. Here, the photo-curable ceramic coating layer contains ceramics that become an insulating layer in addition to containing a photo-curable resin. After being irradiated with

light, therefore, the photo-curable ceramic layer on the circuit-forming pattern is removed by developing, so that the circuit-parts sheet having the circuit-forming pattern in the insulating layer (cured body of the photo-curable ceramic layer) is formed on the carrier film. Therefore, the sheet has the circuit-forming pattern exposed on both surfaces thereof. Upon peeling the carrier film, the sheets are laminated one upon the other and are fired to produce the desired multi-layer circuit board.

The above method is illustrated in Figures 2 and 3, with steps (a) to (c) being shown in Figures 2(a) to 2(e). The circuit-parts sheet A is obtained through the steps (a) to (e). The circuit-parts sheet A comprises a portion of the photo-cured ceramic sheet (20) and a portion of the circuit-forming pattern (22). The circuit-forming pattern (22) of the circuit-parts sheet A has both of its surfaces exposed.

Next, through the steps (f) to (h), a plurality of pieces of the circuit-parts sheets are prepared, laminated and fired to produce the multi-layer circuit board. The steps (f) to (h) are depicted in Figures 3(a) and 3(b).

The production protocol discussed above allows the thickness of the circuit-forming pattern and the thickness of the photo-curable ceramic coating layer to be substantially equal to each other. This avoids the occurrence of a step (difference in level) that results from the thickness of the circuit-forming pattern. And this then reliably prevents the occurrence of peeling resulting from the step and deformation due to forcible pressure at the time of forming the laminate. In addition, a circuit pattern having an increased thickness can be obtained.

Furthermore, as discussed above, the circuit-parts sheet has the circuit-forming pattern exposed on both surfaces. Therefore, the circuit board can be obtained by simply laminating a number of circuit-parts sheets followed by firing. This has the advantages of providing simplified processing and a lower production cost.

Applicant respectfully submits that the Office has misinterpreted Hayashi. In particular, Applicant believes that it is apparent that Hayashi's multi-layer wiring board, as shown in Figure 1 of Hayashi, has a significantly different structure than that of the multi-layer circuit board of the present invention (Figure 3). Hayashi's multi-layer wiring board, as depicted in Figure 1 of Hayashi, comprises plural circuit board units (A, B and C). Each of these circuit board units comprise an insulating board (1c, 1b, 1a), a wiring layer 2 and a via-hole conducting passage 3. An important difference between Hayashi and the present invention is that the circuit board units of Hayashi do not have wiring circuit layers on both surfaces and they do not have via-hole conducting passages in both surfaces.

Furthermore, Applicant respectfully disagrees with the following statements made by the Office:

- (1) The Office at p. 3, lines 7-12 of the present Office Action states,

"Hayashi, in col. 6, lines 22-25 and in col. 15, lines 40-60, discloses that the photocured ceramic sheet (insulating board with the wiring circuit pattern layer) can have total thickness not larger than 50 μm (10 μm insulating board + copper foil thickness = 22 μm), and the difference in thickness between the circuit pattern thickness and the insulating board (thickness difference between the circuit-forming pattern and the photocured ceramic sheet) is less than 5 μm , i.e., 2 μm (claim 11)." _____

The above statement is primarily based on Example 2 of Hayashi but is believed to be incorrect for the following reasons:

Hayashi does not use a "photocured ceramic sheet." The insulating board in Example 2 of Hayashi comprises 55% by weight of a polyimide resin and 45% by weight of a silica as an inorganic filler, and is heat-cured. Therefore, the insulating board is formed by using the polyimide resin which contains silica as a filler. Therefore, the composition is not the ceramics. Furthermore, in Example 2, as described in column 16, lines 16-23 of Hayashi, it is apparent that the circuit board

units are laminated, adhered and heated in a manner similar to that described in Example 1 (Hayashi, column 14, lines 22-28). Therefore, the polyimide in the insulating board is completely cured having been heated at 200°C.

Therefore, it is further apparent that the insulating board is not the one that is photocured. Example 2 executes the irradiation with light and it appears that the Office is mistaking the irradiation as the photocuring.

Instead, the irradiation with light is for lowering the tackiness of the tacky layer formed on the transfer sheet to facilitate the peeling (Hayashi, column 16, lines 12-15). Stated differently, the irradiation with light in Example 2 of Hayashi is for lowering the tackiness of the transfer sheet and for facilitating the peeling of the sheet, but is not for curing the polyimide.

(2) The Office at p. 3, line 17-p. 4, line 2 of the present Office Action states,

"Hayashi, in col. 7, lines 60-67, in col. 8, lines 1-67 and in col. 15, lines 42-60, discloses that the circuit forming pattern (circuit wiring) and the insulating board composition (thermosetting resin, thermally curable, i.e., thermally disintegrating resin or thermally extinguishing pattern) are so formed that the circuit wiring pattern and the thermosetting resin pattern (insulating board composition) forming a single layer of insulating board with circuit wiring in it and that they (circuit pattern and thermally extinguishing pattern) are not overlapped but rather embedded or buried in the layer (see figure 2(A))(claims 15-16."

Based on the above statement, Applicant believes the Office misinterprets that the ceramic sheet 20 in the circuit-parts sheet of the present invention is formed by using a thermosetting resin. This is not the case.

As described in the step (b), the ceramic sheet 20 in the circuit-parts sheet of the present invention is formed by irradiating the photo-curable slurry containing an electrically insulating ceramic material with light so as to be photo-cured (step (c)) and, further, followed by firing (step (h)).

Finally, the ceramic sheet 20 in the circuit-parts sheet is substantially formed at the ceramic material and does not contain the thermosetting resin.

In contrast, the insulating board 1 of Hayashi is made from a thermosetting resin (heat curable resin), and because a thermosetting resin is used, it is very difficult to set the thickness of the circuit-forming pattern to be substantially equal to the thickness of the photo-curable ceramic coating layer as is accomplished in the present invention.

Furthermore, according to Hayashi, the via-hole conducting passage 3 must be formed in the circuit board unit. In contrast, in the present invention, no via-hole is formed in the circuit-parts sheet and there is no need for forming the via-hole.

Ogata cannot remedy the defect of Hayashi and is not relied upon by the Office for such. Instead, the Office cites Ogata for teaching after the completion of the multi-layer circuit board laminate, the laminate is fired in a firing furnace.

In light of the foregoing, Applicant respectfully submits that the cited references cannot render claim 9 obvious, because the cited references fail to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 10-18, similarly, require "forming a photo-cured ceramic sheet by photo-curing said photo-curable ceramic coating layer which is not present on the circuit-forming pattern by the irradiation with light from the back surface of said carrier film, wherein the photo-curable ceramic coating layer which is present on the circuit-forming pattern is not photo-cured"; and are therefore, patentable over the cited references for the reasons discussed above. Withdrawal of this rejection is thus respectfully requested.

Applicant believes the foregoing amendments comply with requirements of form and thus may be admitted under 37 C.F.R. § 1.116(b). Alternatively, if these

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amendments are deemed to touch the merits, admission is requested under 37 C.F.R. § 1.116(c). In this connection, these amendments were not earlier presented because they are in response to the matters pointed out for the first time in the Final Office Action.

Lastly, admission is requested under 37 C.F.R. § 1.116(b) as presenting rejected claims in better form for consideration on appeal.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4600 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
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